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The strategies used by children in word recognition are examined. A critical review of some of the classical research which has influenced current thinking about how words are recognized is presented along with a discussion of some of the errors which can be found in these studies. A five-stage model of how beginning readers learn to recognize words is described as including unusual characteristics of words, word shape cues, phonics, context, and sight words. Contrasts are made among recent experimental findings concerning cues used in word recognition and some commonly held beliefs on the subject. Results of recent studies indicate that children prefer to use first letters, final letters, middle letters, and word shape (in that order of preference) as cues to word identification. Discrimination studies indicate that children select the easiest cue for word recognition and that initial training on a list of words with low discriminability which forces attention on all letters, in contrast to training on a word list of high discriminability, encourages the child to adopt a strategy which provides a better basis for transfer to learning new words. Although letter-name knowledge does not seem to have any beneficial effect on reading, there is evidence that letter-sound training does have a positive effect. A bibliography is included. (WB)

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Modes of Word Recognition[1]

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This paper:

1) Examines the strategies used by children in word recognition.
2) Reviews critically some of the classical research which has influenced current thinking about how words are recognized.
3) Presents a five stage model of how words are recognized by beginning readers.
4) Contrasts recent experimental findings of cues used in word recognition with some of the commonly held beliefs about cues used in word recognition.
5) Discusses some of the errors which can be found in classical studies on word recognition.
6) Reviews studies which find that letter-name knowledge has no effect on learning to read.
7) Presents data from experiments on the effect of phonic versus look-say methods of teaching reading along with findings regarding the perceptual unit of recognition.

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MODES OF WORD RECOGNITION

When a word is presented visually and the experimental subject says the appropriate word, we say the word has been recognized. The purpose of this paper will be to examine the strategies used by children in learning to read words, to review critically some of the classical research which has influenced current thinking about how children recognize words, and to present some of the critical issues regarding word recognition.

Strategies Used by Children in Learning to Read Words

Before the student has learned enough about reading to recognize words independently, the earliest stages of the learning to read process may be conceptualized within the framework of a five stage model.

1. Stimulus presentation. A stimulus complex is presented. This consists of the printed stimulus as it appears in a book or on a screen.

2. Cue selection-discrimination learning. Some aspect of the total stimulus complex is selected as the cue to which the response will be attached. In order to determine which aspect of the stimulus complex can be used to distinguish this word (or letter) from others, discrimination learning is involved. For example, the stimulus h-i-p-p-o-p-o-t-a-m-u-s may be presented and the student must learn to say the appropriate word. If this word is the longest among the list

to be learned, then word length may be the cue. Reading is a complex act and numerous cues may be utilized (23). The cue upon which the learner focuses his attention may be a letter, letter group, word shape, in fact, any characteristic which helps to set this word apart from others.

3. Visual Recognition Memory. Having selected a cue, the learner must be able to recognize it again. Travers (27) has suggested that visual recognition memory of the cue is part of short term memory. Recent work on paired-associate learning has demonstrated the importance of visual recognition memory in associative learning (1, 13). An investigation of the relationship between visual recognition memory and reading achievement disclosed the two were significantly correlated (r=.35). To rule out the possibility that the correlation between visual recognition memory and reading simply reflected the well-known relationship between intelligence and reading achievement, the correlation between visual recognition memory and intelligence was computed. The correlation was found to be extremely small (20). Thus, visual recognition memory is related to reading achievement independent of intelligence. The correlation between visual recognition memory and paired-associate learning for the above students was r=.43.

4. Response availability. The appropriate response must be available for hook-up with the cue if learning is to take place. By increasing response availability through the control of context and the associative connections

between words, learning to read new words can be facilitated (16, 22, 24). For example, if the child can already read the word "green" and the new word to be learned is "grass", response availability for the new word should be higher in the context "green grass" than if the word "grass" is presented by itself. Reading speed and recall are also influenced by the associative connections between words (17). When third graders were given a high-association paragraph with sentences such as:

> "They were all happy to be together again. Outside the moon and stars shone brightly in the June sky, and the green grass sparkled in the night."

they read it significantly faster and with better recall than a group getting a low-association paragraph with sentences such as:

> "They were all relieved to be together again. Outside the moon and lake appeared clearly in the June evening and the green house sparkled in the valley."

Bormuth (4) and Ruddell (15) have found that linguistic variables can affect comprehension. It would be interesting to determine if some of the linguistic variables which affect comprehension also affect learning to read new words.

5. Hook-up or associative stage. When the cue and the appropriate response are hooked-up, we can say the learner is able to read or recognize the word, i.e., upon stimulus presentation he can say the correct word. According to

Travers (27), the hooked-up cue and response are part of long term memory.

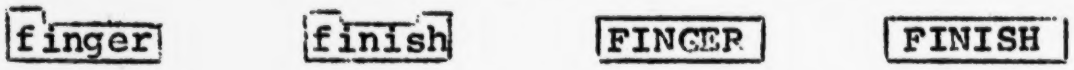
The unskilled reader who is learning to recognize a word must select a cue, recall the cue, and have the appropriate response available for pairing with the cue. Various strategies have been described which beginning readers use to recognize a word. Some of these are listed below along with critical comments, many of which will be elaborated upon later in the paper.

1. Recognition of words as sight words. The words to be learned are presented to the student. His task is to learn to say the appropriate word which is associated with the visually presented stimulus. This procedure is often referred to as the look-say method and is frequently used in early reading training. What is of concern with the use of this method are the strategies used in learning and their subsequent effect on later learning. The words "boy" and "cat" may have been presented. Although the student learns to recognize the words, he may do so because he used letter "b" as the cue for "boy" and letter "c" as the cue for "cat". Later when shown the words "ball" and "car" the student may call these words "boy" and "cat" because he relys on single letter cues "b" and "c" as cues for recognition.

2. Unusual characteristics of words. The learner may use as his cue for recognition some unusual or striking

characteristic of the word. He may use word length as the cue to identify words in a list. For example the learner may note that the short word is "cat" and the long word is "elephant" He may note the tail on the word "monkey". or the spot of ink on a flash card. These may serve as cues to accurate recognition for a while. This strategy becomes ineffective when other long and short words are encountered.

3. Word shape cues. If lines are drawn about words printed in lower case, a characteristic outline or shape results. This outline can serve as a cue to recognition. If the same word were typed in upper-case, a less characteristic outline results, and consequently, is a less useful cue.



4. Phonics. Individual letters and letter clusters may be used as cues for sounds. These sounds may be combined sequentially to recognize the word. Critics of the phonic method of teaching word recognition claim that English is not a highly alphabetic language, that is, in English there is low correspondence between letters and sounds. This is true only at the level of individual letters. When individual letters as well as letter clusters and their positions in the word are taken into consideration, recent work in linguistics indicates that English has higher letter-sound correspondence than ever

before realized.

5. Context. Word associations and information provided in the context of a sentence may provide the response necessary for recognizing the word. Red, white, and ____. Few English speaking people require the printed stimulus to recognize the missing word. While context provides an important cue for recognition and for learning to read a word, it is important to determine if the reader can recognize a word when it is presented in isolation. If the student does not visually attend to the stimulus when he says the word, he may not learn to read it.

When the beginning reader uses strategies such as recognizing words as sight words, using unusual characteristics of words and word shape as cues, he is learning strategies which not only are not useful for transfer but will have to be abandoned if he is to progress to the point where he can decode words on his own. Teachers who encourage their beginning students to use word shape and the whole word as cues have the mistaken belief that children ordinarily note a whole configuration. One reading textbook states "To start with a whole word is sound psychologically, for young children are not prone to be very analytical in their perceptions. Their natural tendency is to perceive total patterns" (26).

If there is anything which discrimination studies indicate, it is that children select the easiest cue for

recognition, and the easiest cue is frequently just a single letter of a word or some incidental detail. Children do not ordinarily attend to total patterns nor to all the letters in a word. It is only when single letter cues fail to distinguish one word from another that children attend to all the letters.

To determine which cues non-readers and beginning readers use in word recognition, Marchbanks and Levin (12) had kindergarteners and first graders select the one word from a set of alternatives which was similar to a standard. The selection could be on the basis of word shape or letter cues. The results indicated that children preferred to use first letters, final letters, middle letters, and word shape (in that order of preference) as cues to word identification. This study is important because it demonstrates that the theories are untenable which propose that beginning readers recognize words as wholes primarily by shape. It also demonstrates the importance of letter cues in the word recognition of children.

Under which conditions will children use single letter cues or all the letters in the word as cues to recognition? To find the answer Samuels and Jeffrey (21) gave kindergarteners a list of four words to learn to read. One group learned a list where the words were easy to visually discriminate from each other. This group was called the high discriminability group and their words were spelled DA, BE,

MI, SO. Another group was called the low discriminability group and their words were difficult to visually discriminate from each other. The words were spelled SE, SA, ME, MA. A comparison between the two groups on speed of learning to read the words indicated that the group getting the list with highly discriminable words excelled. Then a test was given to determine the letters used as cues for recognition. The test revealed that the high discriminability group, which had learned more quickly, had used single letter cues as the basis for recognition. The low discriminability group, although learning less rapidly, had used both letters as the cue for recognition. When children in both groups were shown a word spelled "MO", a word they had not seen before, those from the high discriminability group were apt to say the word was "MI" or "SO", depending on whether they used a first or last letter as a cue in recognition. Those in the low discriminability group tended to say the word was one they had not seen before. Thus, initial training on a list of words with low discriminability, which forced attention on all the letters, encouraged the child to adopt a strategy which provided a better basis for transfer to learning new words.

In teaching reading to beginning readers, a decision must be made between speed of initial learning and transfer. The decision to foster speed of initial learning at the expense of transfer may be a false economy. Initial

speed of learning can be facilitated by using the look-say method with words which are highly discriminable from each other. For example, when given the following sentence: "Yesterday our class went to a fire station," the beginning reader would probably learn to read the sentence using first or last letter cues. Although this strategy would lead to rapid learning, it also results in poor transfer to learning how to read new words. In learning to read, the principle of least effort operates. This means that the strategy is to select from the stimulus complex that cue which most easily elicits the covert response. This cue may be word length, shape, or single letters. These cues are irrelevant in that they provide no basis for learning new words and what is learned will before long inhibit future learning.

Teachers who begin the teaching of reading by having the learner recognize a basic group of words as sight words have noted that at first the learning is rapid, but soon the rate of learning new words slows down drastically. The initial rate of learning is rapid because numerous simple strategies provide cues for word recognition. Only so many words can be recognized by length, shape, and single letters before the strategies prove ineffective. When this occurs, the rate of learning new words decreases, and the learner remains on a learning plateau until he learns a rational system for decoding words from symbols to sounds.

One strategy for facilitating word recognition is to use color cues with each word as in the words-in-color system. With this system certain sounds are represented by particular colors. When a word is printed, it is spelled according to standard English orthography, but certain letters are in a particular color which represents the pronunciation. While this system may increase rate of initial learning, the critical question is one of transfer. If the learner focuses his attention on color and not letter shape, what happens when the color cues are removed? To answer this question, Samuels (19) had first graders and college students learn to read words printed in color or words printed in regular type. Samuels found that rate of learning the words in color was significantly faster than the words in regular type. But on the transfer tests--when the color cues were removed--the subjects had great difficulty in recognizing the words formerly in color. Thus, on the transfer tests the tables were turned. In comparing recognition between the words which were always in regular type to the words which had formerly been in color recognition was superior for the words which had always been in regular type. What makes these results so surprising is that the college students knew the color cues were to be removed. Apparently, the color cue was so potent they were unable to focus attention on the relevant cue of letter shape. Again this study illustrates the principle

of least effort in learning and the dangers of a false economy in which there is rapid learning at the expense of transfer.

Presently, many teachers are of the opinion that letter-name knowledge facilitates learning to read. There is mounting evidence, however, that learning to decode words is not aided by letter-name knowledge. The basis for the belief regarding the facilitating effect of letter-name knowledge on reading may originate from the fact that causation is often mistakenly imputed to correlational findings. Bond and Dykstra (3) found in the First Grade Studies that reading achievement was highly correlated with letter-name knowledge; in fact, it was the single best predictor of first grade reading success. Some ten years earlier, Nicholson (7) reported that the correlation between ability to identify lower-case letters upon entrance to first grade and the rate of learning to read words was r=.51, which was higher than the correlation between IQ (r=.36) and the rate of learning these words. In the same report (7), Linehan stated that letter-name and letter-sound training seemed to facilitate first-grade reading achievement. Since the group which got letter-name and sound training received auditory discrimination training as well, it is impossible to determine from this study if the facilitating effect was produced by the name, sound, or auditory discrimination training. Durrell (7) concluded, however, that reading

difficulties could be prevented if, among other things, training in letter names and sounds was given.

Several critical questions must be answered regarding the finding that training in letter names and sounds facilitates learning to read words: (a) Is it letter names, letter sounds, or their combination which facilitates reading acquisition. (b) Can the correlational findings between letter-names and sounds and reading be an artifact or product of some other factor? Ohnmacht (14) used a classroom setting to study the effect of letter-name and sound training on reading. One group was given early training in letter-names. A second group was given training in names and sounds, and a third group served as a control. She found that the group getting training on names and sounds was superior to the other groups in word knowledge and word discrimination. The group getting training in letter-names was no better than the control on these reading measures. It appears, then, that letter-name training in an experimental study does not facilitate reading acquisition.

Samuels was interested in the same question. He did a laboratory study to determine what component of letter-name knowledge, if any, facilitates reading acquisition (18). One of the explanations offered by educators as to why they believe letter-name knowledge facilitates learning to read is that many letter-names are similar to the letter-sounds. It is possible, however, that reading acquisition may be

influenced by the ability to visually discriminate one letter from another and not by knowledge of the letter names. To answer these questions, three groups of children mid-way through first grade were used. The visual discrimination group was given a paired-associate task in which the subjects had to visually discriminate four artificial letters from each other. The letter-name group was given a paired-associate task with the same four letters but subjects had to learn letter-names for each of the letters ("S", "M", "E", "A"). The control group got an irrelevant paired-associate task. Then, the same transfer task was given to all the groups. This task consisted of learning to say the appropriate English word for words constructed out of the artificial letters (SE - "SEE", SA - "SAY", ME - "ME", MA - "MAY"). Surprisingly, no significant differences were found among any of the groups. Since this finding ran counter to the correlational findings, the study was replicated twice, with different laboratory assistants and different first-grade subjects, but always with the same results, i.e., no difference among the groups.

Results from the Ohnmacht and Samuels studies suggest that letter-name knowledge has no positive effect on reading acquisition and that the correlational findings between letter-name knowledge and reading may be a product of some other factor. There is evidence (25) that paired-associate learning ability is significantly correlated with intelligence. Letter-naming is a paired-associate task and may be taken as an index

of intelligence. Since we already know that in the elementary school IQ is highly correlated with reading achievement, it is not surprising that letter-name knowledge is also correlated with reading achievement. Another explanation is that the kind of home background which enables a child to enter first grade already knowing many of the letters of the alphabet would be the kind of home in which academic achievement would be emphasized. Again, it is well known that socio-economic status and home environment are highly correlated with school achievement.

Although letter-name knowledge does not seem to have any beneficial effect on reading, there is evidence that letter-sound training does have a positive effect. The Linehan and Ohnmacht studies both suggested this, and a study by Jeffrey and Samuels (11), which will be discussed later, gives further evidence of this.

Classical Research Which Has Influenced Current Thinking

The research since the 1960's indicates that children tend to select a detail such as a letter as a cue for word recognition. This finding is in variance with the more commonly held belief that children use the whole word or word shape as the cue. How did this latter view originate?

Prior to 1900, Cattell, and Erdmann and Dodge published studies which led to the current belief that beginning readers use whole words and word shape as cues to word recognition. Over the years, partly to support the whole-word method of

teaching reading, books on reading have continued to refer to these studies. Because of their importance, the errors which can be identified in these studies should be pointed out.

Erdmann and Dodge (8) were of the opinion that word length and shape were the primary cues used by skilled readers in word recognition. They came to this conclusion after finding that skilled readers could recognize words that were so far from the fixation point that individual letters could not be recognized, and words could be recognized even when letters were too small to be recognized individually.

It seems fallacious to assume that because skilled readers can recognize a word from its shape and length--under experimental conditions when other cues are missing--that shape and length are the primary cues adults rely on under normal conditions. Secondly, if Erdmann and Dodge are correct about adults using word shape and length as the primary cues, which is doubtful, it seems incorrect to assume, as many educators do, that these are the main cues children use in learning to read. Marchbanks and Levin (12) demonstrated that shape was the cue least used by children. Furthermore, it is apparent that a strategy of learning to read using word shape and length provides a poor basis for transfer to reading new words.

Cattell, in 1885 (6), published a study which led to the present belief that beginning readers use the whole word in word recognition. The major finding in this study was that

readers could recognize a short common word in slightly less time than it takes to recognize a single letter. There are several flaws in this study which should make the reader cautious about concluding that the results of this study apply to children learning how to read. In this study Cattell used a small number of highly educated adults. He had them read aloud as quickly as possible a passage from Gulliver's Travels, spell the letters contained in the words, and then read a passage consisting of 100 common nouns. The most serious error was that the time to pronounce the words is confused with the time it takes to recognize the words. Secondly, he used only skilled readers, and consequently, the findings are not valid for children.

In 1885, Cattell (5) also published a study in which he used a tachistoscope, thus eliminating the problem in the other study where the time to pronounce the word was confounded with the time to recognize the word. He found that in a fixed exposure time, two unconnected letters or two unconnected words could be recognized. Again he used adults, but he did mention one nine-year-old boy in the study who was described as being superior in reading ability to some of the adults.

The Cattell studies demonstrate that skilled readers do not engage in letter-by-letter processing. If they did, then the time for recognizing a word would be the sum of the time necessary for recognizing each of the letters. Many people have interpreted Cattell's results to mean that a skilled

reader uses the entire word as the unit for recognition. This interpretation is not valid because Cattell's experiments were not designed to answer the question of what cues are actually used by skilled readers in word recognition. It is possible that Cattell's readers recognized just some of the letters in the word and were able to correctly identify the word from a partial percept. To infer from these studies that naive readers use the entire word as a cue in learning to read is an error, partly because naive readers were not used in these studies.

Secondly, it is now known that naive readers tend to select a detail rather than the entire word. Third, while it is known that the adult can perceive several letters together as a unit in word recognition, no one knows at the present time when beginning readers perceive these higher-order units.

A higher order unit is a spelling pattern having invariant spelling-to-sound correspondence. For example, a higher-order unit might be "gh" in words like "rough" or "tough". Adults can recognize higher order units which conform to English spelling rules even when they are presented in non-sense words (9). The critical question is: How do beginning readers learn the higher-order units?

In order to study how beginning readers learn higher-order units, Gibson, et al (10) gave kindergarteners and first graders a task in which it was possible for them to learn patterns of spelling. The child was given a set of

eight cards. Four of the cards had words with a higher-order unit such as LACK, MUCK, DECK, and SOCK. The other four cards had words such as LAKE, MUCH, DERK, and SOAK with no higher-order unit. The cards were presented in pairs (e.g., LACK and LAKE), and the child simply had to point to one of the cards. If he pointed to the card with a higher-order unit, that is, a word having "CK", he was told that he was correct. In order to be able to consistently point to the correct card, the child had to learn a strategy for discriminating the higher-order units. Although the task was difficult, Gibson found that for some of the children performance improved indicating that they were learning how to discriminate and abstract the common spelling pattern.

The final topic which will be discussed relates to the findings of a laboratory study testing the effect of phonic versus look-say reading training on transfer to reading new words. In this study (11) kindergarten children were given phonic blend training and then were randomly assigned to a look-say, phonic, or control group. Look-say training consisted of learning to read a list of words. The letters of these words were used in new combinations to form the words used in the transfer list. Phonic training consisted of learning letter-sounds. These letters were used in the transfer list of words. The control group got an irrelevant task to perform. Following training all the subjects were given the same list of transfer words. First the subjects

were shown the words and were asked to read them without any help. Then they were given instruction and the number of trials required for learning the entire list was computed. The results indicated that the phonic trained group was significantly better than the other two groups in number of words read without any help and speed of learning the entire list. There was no significant difference between the look-say and control groups on either of these measures, indicating that look-say training did not provide a basis for positive transfer to reading new words. A similar study was done using college subjects (2). With one exception, the study using college subjects was identical to the one using kindergarten children. Some of the college subjects getting look-say training were able to read words on the transfer list on first presentation whereas virtually none of the look-say kindergarten subjects could do this. An analysis of how the college subjects did this revealed that those subjects who had used their knowledge of reading and who had learned letter-sound correspondences on their own, were able to transfer this knowledge to reading the transfer list. Taken together, the two studies give strong support to the notion that knowledge of letter-sound correspondence is an important basis for transfer to reading new words.

Footnote

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